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TRANSACTIONS OF THE SOCIETY FOR BRITISH ENTOMOLOGY

VOL. 18 DECEMBER 1969 PART XI

The Surface Activity of Beetles in a Northern English Wood

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Introduction

This is an account of a small scale trapping project designed to gain some idea of the locomotor activity of the surface running beetles of Ernocroft wood in north-east Cheshire. In recent years much work has been carried out on the surface running Carabidae. Many of the British species have been studied by Greenslade (1964a, 1964b, 1965) who has summarised much information on their ecology and life-histories. The Staphylinidae have been similarly treated by Kasule (1968), but little information is available for other families.

Site

Ernocroft wood lies on the eastern side of the Etherow valley about 14 kilometres to the east of Manchester. It has a fairly mild climate with just over 90 cms. of rain a year. The sampling site is near the upper, eastern edge of the wood at about 140 metres above sea level, and consists of well spaced ash and sycamore trees. The woodland floor is a mull-type moder with a layer of leaf litter broken up into patches by a wide-spread herbaceous layer of blue-bells and grass (*Holcus lanatus*). The area is described in more detail by Healey (1963) and Fernando (1963). The pitfall traps were 12 one-pound jam-jars placed one metre apart in a line which started two metres from the edge of the wood. They were emptied once a week (with a few gaps) between September 1962 and June 1964. Thus the trapping record consists of weekly captures from 12 traps.

Results

Over 60 species of beetles were recorded from the traps, but about half these species were occasional captures represented by one or a few individuals. The variation in captures of the commonest species has been shown in the histograms (fig. 1), whilst the monthly variation in captures of the less common species has been summarised in table 1. (In this table, weekly totals for the period September 1962-June 1964 have been summed for each of the twelve months; thus each month of the table represents two months' captures, with the exception of July, August and part of September). The occasional species have been listed with their months of capture in table 2. The following observations concern the more important species.

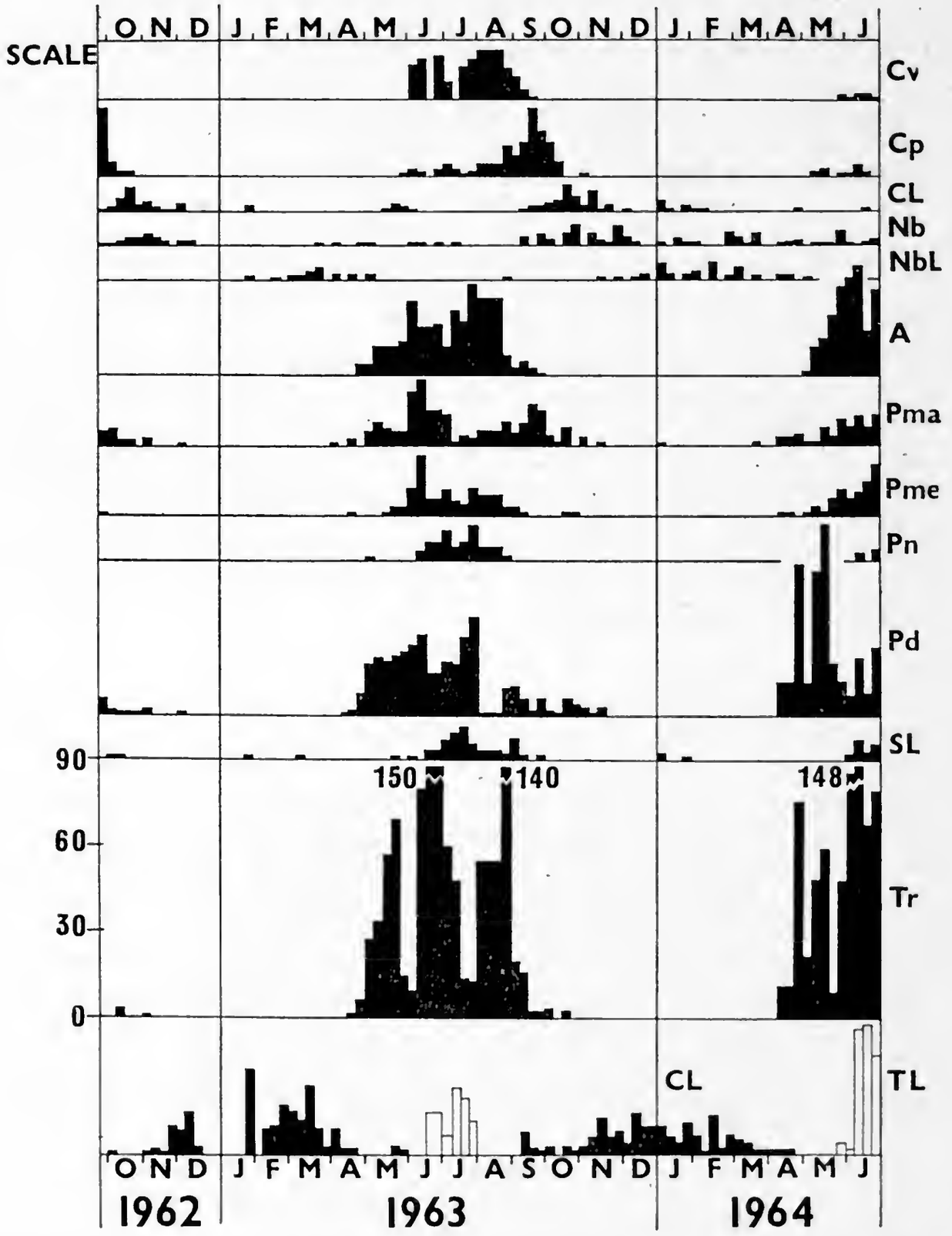

FIGURE 1—Histograms to show the cumulative weekly captures of the commonest surface active beetles in Ernocroft wood between September 1962 and June 1964.

Carabidae: *Carabus problematicus*, Cp; *C. violaceus*, Cv; Larvae of *Carabus* species, CL; *Nebria brevicollis*, Nb; Larvae of *N. brevicollis*, NbL; *Abax parallelopipedus*, A; *Pterostichus madidus*, Pma; *P. melanarius*, Pme; *P. niger*, Pn.

Staphylinidae: *Philonthus decorus*, Pd; Larvae of Staphylininae, SL; *Tachinus rufipes*, Tr; Larvae of Tachyporinae, TL.

Cantharidae: Larvae of Cantharinae, CL.

TABLE 1

Less common species: Months of occurrence

	Jan.	Feb.	Mar.	April	May	June	July*	Aug.*	Sept.*	Oct.	Nov.	Dec.
CARABIDAE												
Carabus nemoralis	—	—	—	7	16	4	—	1	1	1	2	—
Cychrus caraboides	—	—	—	—	1	3	4	3	3	—	—	—
Cychrus larva	—	—	1	—	—	—	—	—	—	4	4	2
Notiophilus biguttatus	—	—	—	2	8	1	—	—	—	3	4	1
Leistus ferrugineus	—	—	—	—	1	—	3	2	1	—	—	—
Leistus spp. larvae	—	10	7	—	—	—	—	—	—	—	—	—
Loricera pilicornis	—	—	—	15	17	15	2	—	—	—	—	—
Pterostichus strenuus	—	—	—	6	6	2	—	1	—	—	1	—
Pterostichus & Abax larvae	—	—	—	2	1	4	—	1	1	4	2	1
Bradycellus verbasci	—	1	1	1	1	—	—	—	—	1	1	1
STAPHLINIDAE												
Staphylinus aeneocephalus	3	4	1	1	1	—	—	—	—	—	—	1
Quedius fuliginosus	4	2	4	15	18	9	1	—	—	5	9	3
Quedius picipes	—	—	—	—	—	—	—	1	1	3	—	—
Gyrohypnus punctulatus	7	7	6	8	6	3	—	—	—	3	8	1
Gyrohypnus myrmecophilus	3	2	1	5	—	—	—	1	—	—	1	3
Xantholinus linearis	5	2	—	1	3	—	—	—	—	2	1	4
Lathrobium brunnipes	1	—	—	—	1	—	—	—	1	—	2	1
Anthobium unicolor	—	—	1	—	1	—	—	—	4	2	5	—
Acidota crenata	—	—	—	1	1	—	—	—	—	4	8	—
Acidota cruentata	—	—	1	1	1	—	—	—	—	—	—	1
ANISOTOMIDAE (CATOPINAE)												
Catops nigritus	—	—	—	2	8	18	10	4	3	14	14	2
Nargus velox	1	—	—	—	2	—	—	—	3	5	1	—
HYDROPHILIDAE												
Anacaena globulus	—	—	1	6	26	9	2	1	11	6	2	1
ELATERIDAE												
Agriotes pallidulus	—	—	—	—	10	9	4	—	—	—	—	—
Athous haemorrhoidalis	—	—	—	—	1	14	—	—	—	—	—	—
CURCULIONIDAE												
Otiorrhynchus singularis	—	—	—	1	8	36	58	17	4	4	3	—
Barypithes araneiformis	—	—	—	—	2	12	1	2	1	19	3	—

*July, August and first half of September — records for one year only (1963)

TABLE 2

List of occasional species

Months of occurrence are indicated in brackets (I-XII).
Carabidae: *Leistus fulvibarbis* Dej. (X); *L. terminatus* (Hel.) (X); *Bradycellus harpalinus* (Ser.) (IV, XI); *Calathus piceus* (Marsh.) (VI); *C. micropterus* (Duft.) (VII); *C. fuscipes* (Gz.) (IX).
Staphylinidae: *Stenus impressus* Germ. (IX); *Philonthus laminatus* (Cr.) (V); *Quedius molochinus* (Gr.) (IX); *Tachinus laticollis* Gr. (I); *T. marginellus* (F.) (XII); *Tachyporus chrysomelinus* (L.) (IX); *Olophrum piceum* (Gyll.) (XII); *Sipalia cicellaris* (Grav.) (VIII); *Amischa analis* (Grav.) (I).
Ptiliidae: *Acrotrichis intermedia* (Gill.) (IX).
Scydmaenidae: *Neuraphes elongatulus* (M. & K.) (V).
Silphidae: *Necrophorus vespilloides* Herbst (VI; VII; VIII; IX); *N. investigator* Zet. (VII; VIII).
Hydrophilidae: *Helophorus brevipalpis* Bed. (X); Hydrophilid larva, probably *Anacaena globulus* (Payk.) (V; IX); *Megasternum obscurum* (Marsh.) (VII; IX).
Elateridae: *Denticollis linearis* (L.) (VI).
Cantharidae: *Podabrus alpinus* (Payk.) (VI); *Cantharis rustica* Fal. (VI); *C. nigricans* (Mull.) (VI); *C. pellucida* F. (VI); *Rhagonycha lignosa* (Mull.) (V; VI); *Malthodes* sp. larva, probably *M. marginatus* (Lat.) (XI).
Phalacridae: *Phalacrus coruscus* (Panz.) (VI; X; XII).
Nitidulidae: *Epuraea melanocephala* (Marsh.) (V).
Byrrhidae: *Simplocaria semistriata* (F.) (XI; XII).
Curculionidae: *Phyllobius pyri* (L.) (VII).

Carabidae (figure 1, tables 1 and 2)

On the whole, the surface activity shown by Carabidae in Ernocroft wood agrees with that demonstrated by Greenslade (1965) in a southern English woodland, and all the species shown in figure 1 and tables 1 and 2, will not be described in detail. However, some divergences from the findings of other workers may be noted. The main activity peak of *Carabus violaceus* L. at Ernocroft was rather later than at Silwood (Greenslade, 1965) and at Ernocroft roughly similar numbers of *C. violaceus* and *C. problematicus* Hbst. were trapped. This was similar to the *Carabus* activity in Dutch beech forest (Drift, 1951).

Abax parallelopipedus (P. & M.) was the most commonly trapped Carabid, and its period of peak activity was similar to that at Silwood. However, Murdoch (1967) recorded a peak activity period in April and May from pitfall traps set in marshland or beside streams. All the year round activity is characteristic of *Pterostichus madidus* (F.), but the June and September peaks at Ernocroft differ from the usual single activity peak of July/August found, for instance, by Williams (1959) and Greenslade (1965) in southern England. Breeding takes place in the summer and larvae occur from autumn until early the following summer, when adults start to emerge. Greenslade found that

a number of adult females overwinter to reappear next spring, thus producing a slight activity peak corresponding to an early breeding season. In Ernocroft wood, this early preponderance of females was noticeable in April and May of 1963, although not in the June peak. The April/May ratio of 4:1 females to males in 1963 contrasts with an almost 1:1 sex ratio during this period in 1964. The small number of *Abax* and *Pterostichus* larvae caught were of the larval overwintering species and were trapped mainly in the spring and autumn. Their small number apparently reflects a greater degree of activity in the litter and soil, with much less surface running than in *Carabus* and *Nebria* larvae.

Occasional species of *Bradycellus* were caught throughout much of the year. They were mainly *B. verbasci* (Df.) with only two specimens of *B. harpalinus* (Se.). Although it showed very little surface activity, *B. verbasci* was the commonest Carabid of the trapping site. The actual numbers of *Bradycellus* species (mainly *B. verbasci*) on the site as determined by litter and soil sampling were, on average, between 4 and 5 per square metre. The *Bradycellus* species also differ from most of the other Carabidae on the site in being mainly herbivorous.

Staphylinidae

Philonthus decorus (Grav.) (fig. 1)

This was the most active surface runner amongst the larger Staphylinidae. Adults were found in the litter or soil during most months of the year, but showed two main activity peaks, an early one in the spring and a later one at the end of June. There was a marked difference between the first six months of the years 1964 and 1963. The first activity peak in 1964 was about a month earlier than that of the previous year (which began with a long, cold winter) and included three weeks with about twice as many captures. In Holland, Drift (1951) found *P. decorus* to be most active between the end of April and the beginning of August, although it was trapped in rather small numbers. In Wytham Wood, Berkshire, where it was a very common species, Frank (1967a) found the major activity peak in August/September/October, corresponding to the emergence of the new generation.

Staphylininae larvae (fig. 1)

These larvae, which included a high proportion of *P. decorus* larvae (described by Potockaja, 1961) were mainly active on the surface from June to September, with peak activity in July. Like the adults, larvae of *P. decorus* have been found in the litter or soil during many months of the year.

Tachinus rufipes (DeGeer) (fig. 1)

Adults of this species were trapped in larger numbers than those of any other beetle on the site. They were common between

April and the first half of September, but very few specimens were captured outside this period. They first became abundant in April or May and then declined in numbers before reaching their first activity peak in June. There was a second decline in July before the second activity peak which was reached in August. Callow adults were commonly trapped in August and September. Kasule (1968) also trapped this species commonly between April and October in an oak wood in Scotland, but the peak period was clearly in May/June.

Tachyporinae larvae (fig. 1)

Many of these were larvae of *T. rufipes* (figured by Kasule, 1966). Their surface activity period was restricted to the months of June and July, with very few exceptions. This agrees with the results of Kasule (1968), who has given details of the life history. Tachyporine larvae can be found in soil samples throughout the year, although the highest densities are present in June.

Other adult Staphylinidae (table 1).

Quedius fuliginosus (Grav.) was the most frequent of these to be trapped. It occurred throughout much of the year except in late summer, and had a main activity peak in April and May, with a subsidiary peak in November. Drift (1959) also found the main activity peak in spring and early summer, whilst in Scotland, Kasule (1968) found that this occurred in June. *Gyrohypnus* (=*Othius*) *punctulatus* (Goeze) had a rather similar activity pattern, and this was also noted by Drift. *G. myrmecophilus* (Kies.), *Xantholinus linearis* (Ol.) and *Staphylinus aeneocephalus* (Deg.) were all trapped early and late in the year, and rarely in the summer when *Q. picipes* (Man.) was caught. The most active Omaliinae present, *Anthobium* (=*Lathrimaeum*) *unicolor* (Marsh.) and *Acidota crenata* (F.), were trapped mainly in the autumn, with occasional specimens (together with a few *A. cruentata* (Man.)) being caught in the spring. This agrees with Kasule for *A. crenata,* but Kasule found an April activity peak for *A.* (=*L.*) *unicolor* which corresponded to the new generation. The numbers of this species trapped in Ernocroft wood are too small to show this. Some of the above species (e.g., *G. punctulatus* and *G. myrmecophilus*) are not less common in the soil than *P. decorus,* but show markedly less surface activity. This is true of many of the common soil Staphylinidae which are thus rarely trapped. For instance, the commonest adult beetle of the site floor (as determined by soil samples), *Sipalia circellaris* (Grav.), was trapped only once.

Cantharidae (fig. 1)

Cantharid larvae were trapped throughout most of the year except for the summer months. They were particularly common from November to March, and were the commonest beetles trapped during the winter months. They are active predators, and have

even been seen moving across the snow (in January 1963). Although snow covered the traps in the winter of 1962-63 and no beetles were caught for a period of over a month, during a temporary thaw in the last week of January, more Cantharid larvae were caught than during any other week. The trapped larvae were usually large (up to 20 mm.), although the majority of larvae in the soil (as determined by soil samples) were small, and included *Malthodes* larvae as well as early instars of the trapped larvae. Cantharid adults occasionally fell into pitfall traps in May and June, and these included *Podabrus alpinus* (Payk.), *Cantharis rustica* Fall., *C. nigricans* (Mull.), *C. pellucida* F. and *Rhagonycha lignosa* (Mull.). These species, together with *C. pallida* Gz., *Metacantharis clypeata* (Ill.) and *R. limbata* Thom., were also collected on the site in June by sweeping the vegetation. Adults of the small Cantharid *Malthodes marginatus* (Lat.) were also common at this time. Most of the species have been observed pairing in late May, or in June, and the pitfall captures may have represented egg-laying activity. Pairs of *Malthodes marginatus* and *Rhagonycha limbata* have been kept in the laboratory and it was noticed that the females usually laid eggs in concealed positions.

Drift observed that the smallest Cantharid larvae were caught in August and October, the largest in autumn, winter and spring, and middle-sized larvae throughout the year. He concluded that the larvae were full grown and pupated in the second spring after their birth. He also assumed that all the larvae belonged to a single species of *Cantharis*. In Ernocroft wood, the size of the largest larvae suggests that at least the larger Cantharidae are present. The commonest adults in May and June are probably *C. nigricans* and *C. pellucida,* but probably all the Cantharidae in the wood have soil-living larvae.

Anisctomidae-Catopinae (Table 1)

Catops nigrita Er. was a fairly frequently trapped beetle. It showed two main peaks of activity, the first in June and the second in October and November. The smaller *Nargus velox* (Sp.) was much less common in the wood, but was trapped most often in the autumn. Larval Catopinae were not caught in pitfalls, but were present in litter on the site.

Hydrophilidae

Anacaena globulus (Payk.) (Table 1).

This small beetle occurred throughout the year in the soil and in the litter, and also fell into pitfall traps in most months of the year. It had a main activity peak in May with a subsidiary one in the autumn. *Anacaena* larvae (Balfour-Browne, 1958) were trapped on only two occasions, but are fairly common in the litter and soil during the summer and autumn. Thus the first peak of *A. globulus* in May probably represents reproductive activity. The larvae are active predators although the adults are probably

omnivorous or herbivorous. The beetle has been described as being very common and widely distributed in Britain in most types of water, though its particular type of habitat is difficult to determine because of its wanderings from one spot to another (Balfour-Browne, 1958). A second Hydrophilid trapped on the site was *Helophorus brevipalpis* Bedel.

Elateridae (Table 1)

Adults of three species of click-beetles were occasionally trapped between May and July. Apart from a single specimen of *Denticollis linearis* (L.), they belonged to the two commonest species found on the sycamore-ash site, *Agriotes pallidulus* (Il.) and *Athous haemorrhoidalis* (F.). *A. pallidulus* was mainly trapped in May and June, whilst *A. haemorrhoidalis* was found almost entirely in June. The ecology and life histories of these Elateridae have been studied in detail in Ernocroft wood by Fernando (1963) on this same site. The adults of *A. haemorrhoidalis* which are active on the woodland floor in early summer include those newly emerged from pupal cells, and females laying eggs on or beneath the soil surface. The larvae of both species are wholly soil dwellers and none were captured in pitfalls. Most of the *A. haemorrhoidalis* occurred in the upper part of the soil, in contrast to *A. pallidulus* which was commonest at a depth of between three and six inches. The larval life of *A. haemorrhoidalis* may last from six to eight years, and include 13 or 14 instars. These larvae are mainly root feeders but the younger instars are cannibalistic, and older larvae have been seen feeding on weevil larvae. The larvae of *Denticollis linearis* are normally predaceous.

Curculionidae (Table 1)

Adult weevils were trapped fairly commonly between April and November. *Otiorrhynchus singularis* (L.) was most active in the summer with a marked activity peak in the first two weeks of July, whilst the small *Barypithes araneiformis* (Schr.) showed activity peaks in both June and October. The earliest adults of *O. singularis* to appear in April and May included callows. Both adults and larvae of these species are found in the soil, the larvae being root feeders. The adult *O. singularis* probably feeds above ground during the summer and may eat leaves, buds and young stems. It has been recorded in continental Europe as a pest of young oaks.

Other Species

A list is given (Table 2) of those species which were very occasionally trapped. It includes a number of true soil beetles, that is, species which are common in the soil but which show hardly any surface activity. These include *Sipalia circellaris* (Grav.), *Amischa analis* (Grav.), *Acrotrichis intermedia* (Gill.) and *Neuraphes elongatulus* (Mull. & Ke.). There was very little activity by dung beetles and only a single specimen of *Aphodius*

rufipes (L.) was captured. This is in contrast to the Dutch beech forest studied by Drift (1951) where large numbers of *Geotrupes silvaticus* Panz. were trapped. However, Drift noted that many of these may have been attracted by carrion in the traps. In Ernocroft wood, a number of *Necrophorus vespilloides* Hbst. and *N. investigator* Zett, were caught, probably because of the accumulation of dead insects, and an occasional shrew, in the traps.

Discussion

a. *Habitat*

The position of the trapping site near the edge of an open woodland is clearly reflected by the relative activities of the Carabidae. The distribution of British Carabidae in relation to habitat has been studied by Williams (1959), Murdoch (1967) and especially by Greenslade (1964b, 1965). In Ernocroft wood, the four commonest of 20 species of Carabidae (given in percentages of the total number of individuals trapped between July 1963 and June 1964) were:—*Abax parallelopipedus* 30·4%, *Pterostichus madidus* 13·7%, *Carabus violaceus* 13·4% and *C. problematicus* 11·6%. *A. parallelopipedus* and *C. problematicus* are characteristic of woodland edges or boundary zones in lowland Britain, although they have also been trapped in large numbers in moorland areas of North Wales (Pearson & White, 1964). *P. madidus* and *C. violaceus* are widespread species which are common both inside and outside woodlands. *Nebria brevicollis* (6·2%) and *Calathus piceus* (one individual) are species common in extensive litter areas inside woodlands, and this would explain their low activity in the trapping area.

b. *Food*

The great majority of surface running beetles in Ernocroft wood are either predators or scavengers. This applies to nearly all the beetles in figure 1, and to nearly all those in table 1, with the exception of *Bradycellus verbasci, Anacaena globulus* (adults) and the Elateridae and Curculionidae. It is difficult, however, to determine exactly on what animal food these predators and scavengers are feeding. The largest beetles (22-28 mm.) are the three species of *Carabus* and their larvae. These are probably general predators which can deal with larger food than any of the other beetles (except perhaps *Abax*). Their prey may include large caterpillars and large Tipulid larvae found in the litter. It can occasionally include earthworms and slugs, although the latter are eaten particularly by the specialised mollusc-feeding *Cychrus caraboides* (L.).

The second size group contains many more individuals and is formed by the larger Pterostichini (about 14-22 mm.) which includes *Abax parallelopipedus, Pterostichus niger, P. melanarius* and *P. madidus*. These were described by Davies (1953, 1959) as being mainly scavengers and omnivores. In laboratory trials

they have eaten a wide variety of insects, spiders and large woodlice, and act rather as general predators. However, Briggs (1965) has shown that *P. melanarius* readily eats strawberries and has been recorded as eating Douglas fir seeds and sugar-beet roots. This is true to a lesser extent of *P. madidus* although this was less active in the fields studied. Briggs concluded that *P. melanarius* adults may be either carnivorous or herbivorous. It seems that feeding habits in this group are very variable. However, on the woodland floor it is likely that living or dead animals are usually easier to obtain than plant material such as fruits or seeds.

The third size group (about 5-15 mm.) is the largest in individual numbers. Its common Carabids are not very common on the trapping site. They include *Nebria brevicollis* (F.), *Notiophilus biguttatus* (F.) and *Loricera pilicornis* (F.), which are predators of the smaller arthropods. In the case of adult *N. brevicollis,* Penney (1966) examined the crops of over 300 beetles and found that most of the animals eaten ranged in size from 0·5 mm. to 4 mm, and were mainly small flies (38%), Collembola (32%) and mites (23%). The food of the other two species is not dissimilar and seems to consist mainly of small arthropods, especially Collembola (Davies, 1953). The Staphylinidae in the group include the very common *Tachinus rufipes* and *Philonthus decorus* at the extremes of this size range, and *Lathrobium brunnipes* (F.) and the Staphylininae listed in Table 1. These all seem to be active predators of the smaller arthropods, which include Collembola, mites, small Diptera and their larvae, spiders, and the small woodlouse *Trichoniscus pusillus* Brandt (Evans, 1967). Frank (1967a) found that *P. decorus* ate a wide range of small arthropods, and he also showed that it is an important predator of winter moth pupae in Wytham Wood (1967b).

The Cantharid larvae may perhaps be added here, since although the largest may reach about 20 mm., they represent adult beetles of not more than 13 mm. in length. These larvae are also active predators, and will readily eat *Trichoniscus* or similar sized prey in the laboratory. Thus the commonest beetles in this third size group all seem to be active predators of the small soil Arthropoda.

c. *Activity and numbers*

It can be seen from figure 1 that each species of beetle has a peak period of locomotor activity during the year. Greenslade (1965) has shown that the limited period over which Carabidae show maximum activity differs according to the species. He graphed these species and arbitrarily ranked them in a series showing progressively later activity. Kasule (1968) has treated pitfall-trapped Staphylinidae in a similar way. These activity peaks in both Carabidae and Staphylinidae usually represent breeding activity, and during this period the females are building

up food reserves for future egg-laying. Thus the peaks are feeding as well as reproductive activity peaks in the females, and probably in the males as well. If, instead of comparing all the surface active beetles, we group those which appear to have similar feeding habits, we might expect that within these groups the different activity peaks would succeed each other without overlapping if competition were to be avoided. This would apply to both adults and larvae. A division of the predatory and scavenging beetles into three size groups based on feeding has already been attempted. Figure 2 shows that in each of the size groups, although there is some overlapping, most of the activity peaks are, in fact, chronologically separated.

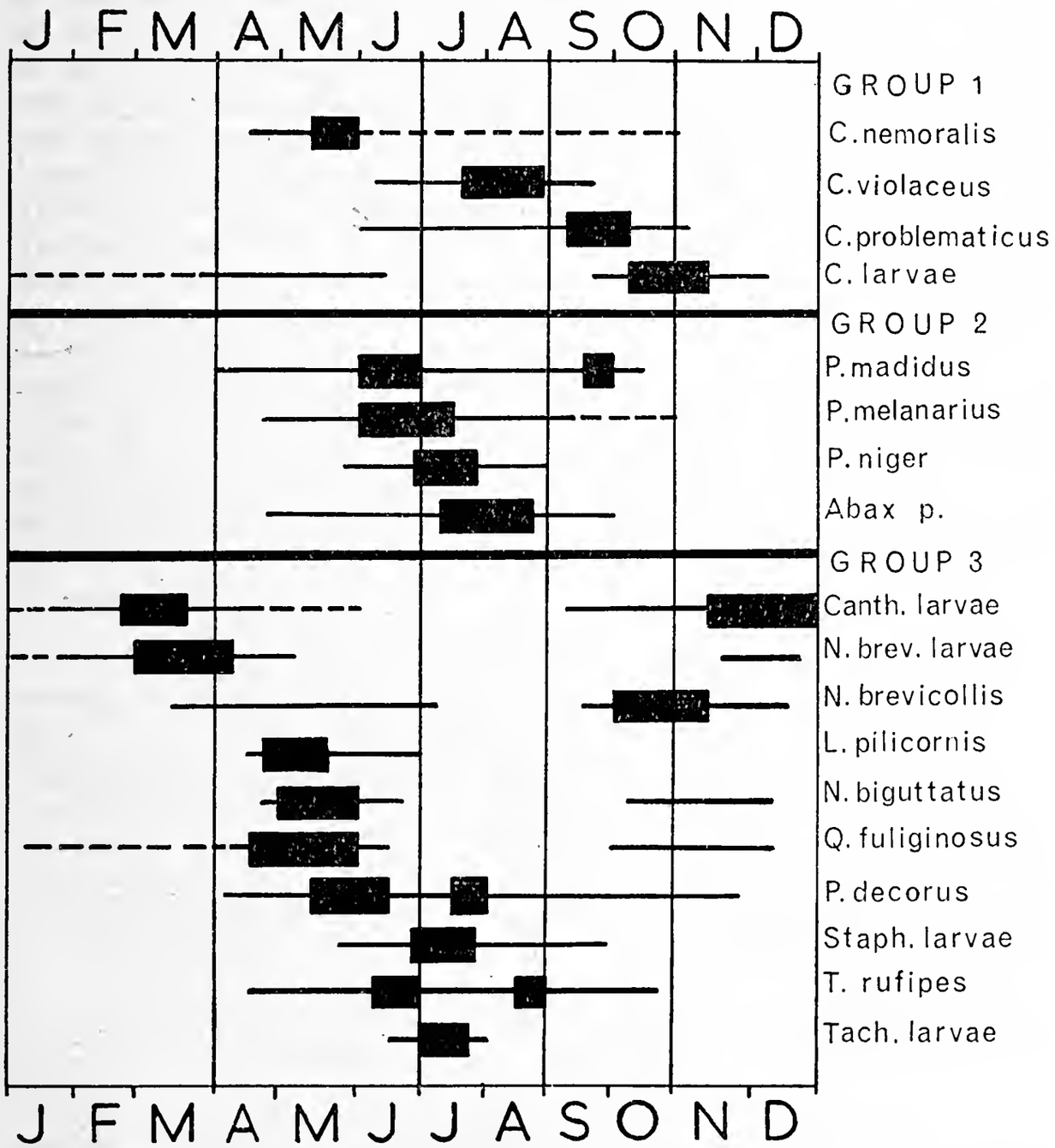

FIGURE 2—The succession of locomotor activity peaks for the surface running beetles of Ernocroft wood. The continuous weekly presence of a species is shown as a continuous horizontal line, whilst more occasional captures are represented by broken lines. The duration of the peak

activity period in each case has been blocked in over the continuous line. The length of this block represents the shortest continuous period during which 50% of the total number of individuals caught fell into the traps. This activity peak has been divided in those species where two peaks were clearly present (fig. 1, *P. madidus*, *P. decorus* and *T. rufipes*). The species have been divided into three size/food preference groups which are discussed in the text.

Of course, the validity of this point depends on the reality of the food groups used, and the natural feeding habits of some of these species are little known. Figure 2 also refers solely to fluctuations in surface feeding activity, but the changes in numbers of a species trapped might reflect differing proportions of surface to subsurface activity, or changes in absolute densities, or both. To determine which factor is involved, an estimation of the absolute numbers of the species on this site would be necessary. An estimate of the densities of the commonest species has been made by direct soil sampling. The animals were extracted by means of Tullgren funnels (Healey, 1963, Fernando, 1963). Unfortunately, the larger Carabidae occur at densities which are too low to estimate in this way; however, the average densities of the commoner beetles can be compared with their amount of surface activity. The densities given in table 3 are based on 15 litter and soil samples, each of 24 units, which were taken between January 1960 and April 1963. They are given as average numbers per square metre per sample. For comparative purposes, the numbers are also given for 450 square metres because these resemble the total numbers of *T. rufipes* and *P. decorus* which were trapped.

TABLE 3

Comparison of numbers trapped and numbers estimated from soil samples

	Total nos. trapped (27.9.62-27.6.64)	Av. no. (per sample)/sq. m. site floor	Av. no./450 sq. m. site floor
Tachinus rufipes	1,585	3·3	1,485
Philonthus decorus	655	1·5	675
Gyrohypnus punctulatus	49	2·3	1,035
Bradycellus verbasci and *B. harpalinus*	9	4·6	2,070
Sipalia circellaris	2	31·3	14,185
Abax parallelopipedus	480	—	—

It can be seen from this table that the proportions of *T. rufipes* to *P. decorus* trapped are similar to their relative densities in the woodland floor. This is in contrast to *G. punctulatus*, the two *Bradycellus* species and *S. circellaris*. These species show much less surface activity than *T. rufipes* and *P. decorus* in relation to their litter and soil populations. This activity can be ex-

pressed in terms of the activity of *T. rufipes* and *P. decorus* as follows: —

(*T. rufipes* and *P. decorus*	100%)
Gyrohypnus punctulatus approximately	5%
Bradycellus verbasci and *B. harpalinus* approximately	0·4%
Sipalia circellaris approximately	0·01%

It seems likely that the very small number of *S. circellaris* trapped represented accidental captures of the sub-surface beetles falling out of litter around the edges of the traps. This may also be true of *B. verbasci* and *B. harpalinus* in Ernocroft wood, although *B. harpalinus* may occur frequently on grasses and low growing vegetation, and has been commonly caught in light traps (Greenslade, 1961). *Bradycellus* species are small, slow moving Carabids, and thus may not be caught as frequently as the larger, fast-moving species. However, outside woodlands some species of *Bradycellus* have been commonly trapped. Pearson & White (1964) captured several species on moorland in North Wales where *B. similis* Dej. was particularly abundant.

Although *G. punctulatus* is apparently about twenty times less active than *P. decorus* and *T. rufipes,* the latter species are by no means completely surface active. For instance, captures of the commonest Carabid trapped—*Abax parallelopipedus*—were nearly three-quarters of *P. decorus* captures. Yet this Carabid is too uncommon to occur in any of the soil samples although numbers of *P. decorus* average about 1·5 per square metre. This suggests that the surface activity of *P. decorus,* as measured by its pitfall captures, is only a fraction of that of *Abax.* In the case of *Abax,* it might be reasonable to suppose that nearly all the locomotor activity of this large Carabid would be confined to the surface. However, even with *Abax* this is not certain, for Kabacik (Greenslade, 1964a) found that the slightly smaller *Pterostichus niger* was active both on and within the litter, in contrast to the rather larger *Carabus arcensis* Hbst. (=*C. arvensis* Hbst.) which moved only on or near the surface of the leaf litter.

In table 3, it is only possible to compare the total activities (i.e. numbers trapped) of the species given with their average densities per square metre. It would be more useful to be able to compare the fluctuations in the activity of a species throughout the year with its fluctuations in density. This has been attempted in table 4 for the most frequently trapped species, *T. rufipes.* The trapping data are shown in terms of average numbers for individual months (1962-1964), and the density data from 17 samples (each of 24 units, 1960-1963) have been similarly treated.

The high numbers trapped in May and June represent

reproductive activity, whilst the peak in August may co-incide with the emergence of the new generation. Larvae are active in June and July, although in Scotland, Kasule (1968) has also found them active in August. The lowest densities of adult *T. rufipes* (except November) occur in this larval period of June,

TABLE 4

Comparison of average numbers of adult T. RUFIPES *trapped per month with its average monthly densities in the litter and soil*

(N.S.—no samples taken in this month)

	J	F	M	A	M	J	J	A	S	O	N	D
Average Nos./ month trapped:	0	0	0	52	194	403	135	314	40	4	1	0
Average Nos./ sq.m. in the soil:	5·2	N.S.	4·8	3·8	N.S.	0	1·4	1·3	2·8	6·6	0·7	2·4

July and August. During all other months of the year (except November) the adults are present in the soil in higher densities which do not parallel their surface activity. Thus we may conclude that in the case of *T. rufipes,* peaks in trapping numbers represent peaks in surface activity, and do not represent increases in density. In fact, peak surface activity in the summer months may actually be accompanied by a decrease in beetle density.

Abstract

The results are given of a pitfall trapping study of the surface active beetles of an open sycamore-ash woodland. The species caught were mainly Carabidae and Staphylinidae, with smaller numbers of Cantharidae, Hydrophilidae and Anisotomidae. A separation of the activity peaks of the common species has been attempted on the basis of size/food preference groups. For several species, the numbers trapped (showing total surface activity) have been contrasted with the numbers actually present in the soil, as determined by direct sampling. For *Tachinus rufipes,* density in the soil has been contrasted with the seasonal fluctuation in surface activity.

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